



Intelligent Transport Solutions for Smart Cities and Regions:

Lessons Learned from an 18-month Trial

Authors:

Rafael Cepeda, MBA, PhD

InterDigital Europe

Rafael.Cepeda@interdigital.com

Ken Figueredo, MBA, PhD

InterDigital Solutions

Ken.Figueredo@interdigital.com

THE SMART CITY PHENOMENON

City authorities find themselves at the confluence of several technology breakthroughs, service innovations and rising citizen expectations which are fueling the smart city phenomenon.

The telecommunications sector delivers a constant stream of low cost and ubiquitous technologies to connect and remotely manage a wide variety of city assets. Internet companies, transport authorities and ride-sharing service providers offer sophisticated journey planning and crowd sourcing applications which improve transportation logistics and add convenience to the everyday lives of commuters. At the same time, consumers see traditional industries embrace internet concepts through services such as online banking, utilities account management and the use of mobiles to pay for car parking.

These innovations raise citizen expectations for public sector services, forcing them to become less bureaucratic and more citizen friendly. Smart city solutions also need to cover a wider range of services than city authorities previously provided. And, all the while, city budgets are under pressure in absolute terms and in relation to budgetary ring-fences around education, health and welfare services. Inevitably, this results in a

squeeze on budgets for innovation and operational transformation.

The financial squeeze led many of the early smart city projects to tackle quick-win, point solutions with a clear, near-term return on investment. Smart street lighting¹ is one example of the savings that a city can achieve. However, if the city then wishes to integrate other smart city services into a common IT environment, or use data from existing street furniture for other purposes, it faces significant integration and life-cycle support costs, problems that several cities are beginning to experience².

The integration challenge does not just apply to citizen-facing applications. City authorities are organized into departmental silos, some of which have outsourced services to private sector firms. These structures create problems when it comes to sharing connected assets and data, within a department and across departments and operational boundaries.

City managers are beginning to see that their initial focus on quick-win, standalone solutions is costly to maintain and difficult to integrate into a unified smart city operating framework. They also have to discover innovative funding and risk-sharing frameworks to break new ground in delivering smart city services. The way forward is to make best use of highly

¹ Lighting the Clean Revolution: The Rise of LED Street Lighting and What it Means for Cities, "LEDs achieve 50 to 70% energy savings, and reach up to 80% savings when coupled with smart controls". https://www.theclimategroup.org/sites/default/files/archive/files/LED_report_web1.pdf

² From Smart Cities 1.0 to 2.0: it's not (only) about the tech, <http://theconversation.com/from-smart-cities-1-0-to-2-0-its-not-only-about-the-tech-73851>

reusable, horizontal platforms, through flexible and expandable partnerships between public and private sector organizations.

SMART CITY START-UP CHALLENGES

Smart city solutions touch new operating boundaries for city managers. A few well-defined applications, such as waste collection or smart, street lighting, might map onto formal, operating budgets. For the most part, however, information gathering and learning, innovation, technology evaluation and trials activities do not have an obvious home in city budgeting frameworks³. Most of the time, these tend to result in isolated efforts with pilots contributing to more fragmentation.

Funding for smart city innovation is the first challenge and a significant barrier to adoption. Government authorities have recognized this challenge and have assigned funding for innovation via programs such as Horizon2020 (Europe), Innovate UK (UK) and the Smart Cities Challenge (USA), for example. Even with seed funding for innovation, cities have to find ways to create scale to avoid addressing narrow solutions and to leverage the skills of other organizations with expertise in different and complementary domains. In addition, there is little consideration of the economic sustainability of solutions and how these can be profitable for cities and citizens.

A second challenge is to strike the right balance between tactical and strategic goals. Most cities lack a complete picture of the assets and data sources under their management. Creating a data inventory is a time and resource absorbing activity. Equally, there are non-trivial data management challenges in harmonizing data from a wide range of existing and future sensors, many of which use proprietary communication and reporting protocols. The strategic challenge is to recognize that each city will manage a growing number of connected assets and data sources. The start-up challenge, therefore, is to experiment by bringing together a few data streams into a common environment to enable data sharing and application mash-ups for different use cases.

Apart from the technical issues involved in this process, smart city authorities will have to deal with internal organizational structures. They will also have to plan for change management requirements associated with becoming a smart city.

The IoT is a relatively new market and one that encompasses a wide range of technologies including connectivity, remote device management, big-data, analytics and augmented reality to name but a few. How should city authorities assess the relevance of these different technologies given that they are primarily not technology organizations? Technology, therefore, can overwhelm the start-up process and lead to

³ *Mobile World Congress 2017: Panel discussion with representatives from Hertfordshire County Council, Oxfordshire County Council. InterDigital and WorldSensing, https://www.youtube.com/watch?v=pjT_zY7xYlg*

inaction or investment in just a sub-set of the overall portfolio necessary to sustain multiple smart city services. One approach to overcome the technology challenge is to work within a multi-party eco-system. Here, different specialists contribute their relevant expertise within the framework of a common goal and model of cooperation. Such an approach combines the best of the public and private sectors.

ONETRANSPORT – A PUBLIC-PRIVATE ECO-SYSTEM FOR SMART CITY AND REGIONAL INNOVATION

The oneTRANSPORT™ initiative is a large-scale, intelligent transport system (ITS) trial⁴, part-funded by Innovate UK. It involves eleven public and private sector organizations with an operational footprint that covers four counties and roughly 10% of the population of England.

Several different user groups share a common IoT platform. This offers significant commercial, technology-management and interoperability benefits. There are obvious commercial benefits from platform sharing and the pooling of knowhow across different disciplines. This is a clear priority for cash-constrained public-sector agencies whose

core mission does not extend to significant capital investments in IoT technologies⁵.



Figure 1 oneTRANSPORT, multi-owner ITS eco-system

Within the trial, five organizations represent the demand and use case points of view. These include four English counties, Buckinghamshire, Hertfordshire, Oxfordshire and Northamptonshire, as well as the Highways England transport agency.

At present, the counties outsource the management of their transport services and have no immediate appetite to own or manage their own IoT platforms. InterDigital addresses this need by providing its IoT platform based on the oneM2M™ standard⁶ as a managed service offering (PaaS) for all

⁴ oneTRANSPORT Open Marketplace for Data, <http://onetransport.uk.net/> oneTRANSPORT is a trademark of InterDigital

⁵ Connect It – oneTRANSPORT: using open IOT standards to connect UK counties, IEEE Communications Society webinar, <http://www.comsoc.org/webinars/connect-it-%E2%80%93-onetransport-using-open-iot-standards-connect-uk-counties>

⁶ oneM2M™ is a trademark of the Partners Type 1 ARIB (Japan), ATIS (USA), CCSA (China), ETSI, TTA (USA), TSDSI (India), TTA (S. Korea), TTC (Japan), www.onem2m.org

trial participants, and data as a service (DaaS) as a result of implementing an “open marketplace for data and data services.”

One of the factors driving the choice of the oneM2M™ standard is to anticipate future growth as the system absorbs or interoperates with platforms belonging to neighboring counties or other transport-sector agencies.

Arup, the international engineering, design and project management firm, contributes its transportation sector expertise. Arup and InterDigital are also responsible for exploring new data monetization business models and developing the oneTRANSPORT business case.

Other trial participants include transport analytics experts from Traak (traditional analytics methods) and Imperial College London (research-based analytics). The trial makes use of over 200 types of data assets belonging to the five customer organizations and two other transport system and infrastructure managers, Clearview Traffic Group and WorldSensing.

Innovate UK, the UK’s innovation agency, provided 70% of the roughly \$5m in funding for this two-year, pre-commercialization trial. The trial aims to explore innovation in intelligent transport, smart regions and data monetization, activities that no individual local authority would undertake on its own. It should also establish a sound understanding of the requirements to progress into commercialization.

ONETRANSPORT APPROACH AND STRATEGIC DESIGN PRINCIPLES

Many smart city initiatives gravitate to quick-win deployments to satisfy a priority use case or local political cause. In the case of the oneTRANSPORT initiative, the project team conducted a feasibility study prior to the launch of a pilot project. This feasibility study explored several strategic issues relating to long term viability, beyond a pilot phase, as well as measures to foster broad adoption within local authorities.

The public-sector authorities involved in the oneTRANSPORT initiative differ from large metropolitan cities, such as London, which have been forerunners of smart city initiatives. As is typical of small and medium-sized agencies, the oneTRANSPORT authorities have comparatively less capacity to direct funding on innovative, smart city pilot projects. Moreover, their service footprint is more varied as it covers rural and urban environments. These smaller localities also need more effective regional integration with neighboring regions to manage commuter journeys that cross geographic and administrative boundaries.

From an architectural design perspective, the variations in operating environment and need for cross-regional cooperation are a key integration point. The oneTRANSPORT team concluded that a data exchange and marketplace approach that conforms to an open standard is the best way to satisfy this need. Some of the key drivers for this approach in the oneTRANSPORT initiative are:

- Standards based, scalable solution that offers the ability to add to the scope of supportable use-cases
- Ability to accommodate brownfield and greenfield assets, beginning with the integration of a wealth of existing data assets belonging to several different authorities into a common data exchange environment
- A partnering approach that fosters diversity (i.e. best of breed partners in different domains) and low barriers to entry for specialist data analytics firms and application developers thereby cultivating a competitive marketplace

In conceptual terms, a shared data exchange and marketplace for smart cities and regions involves an environment where data providers (e.g. owners of sensors, connected assets, public- and private sector data streams etc.) can interact with data consumers. In a fully functioning scenario, there are many different types of data consumers. For example, some data consumers may subscribe to raw data and handle their own post processing to support a smart city application. Other users may specialize in adding value to raw data by supplying clean or meta data streams to other application developers and service providers. And, another category might specialize in analytics to extract features or insights that enable smart city services.

The value of a data marketplace to smart cities is firstly in creating a low-cost IT infrastructure to publish and share city data. Secondly, the marketplace promotes innovation and economic development by encouraging app developers, who possess competencies that most local authorities lack, to deliver app-based services to city authorities, residents and the business community. And, thirdly, revenues from the marketplace become a new commercial opportunity for smart cities to generate a positive financial contribution to their operating budgets.

The data exchange and marketplace idea, which standardizes the technical capabilities to import and export data, also includes commercial and legal rules for data and app monetization. The architecture ensures a common and dependable framework that all participants can factor into their individual product road-map and technology plans.

For a successful outcome, it was important to ensure that technology providers did not impose a solution onto local authority users. Local authorities needed to have a voice in the solution design process and to have their operational and technology concerns addressed. An important feature of the project approach was a process of transparent communications with technology vendors and transport-sector experts to ensure collaboration and

widespread acceptance on the part of city authorities.

The first stage before the field-trials phase took the form of a feasibility study. This drew upon detailed input from cities, via a task led by Buckinghamshire County Council, as to

using the language of internal decision makers and other authorities, to enable faster adoption.

Since solving smart-city problems is not only a technical issue, a large part of the challenge is to bring multiple cities and

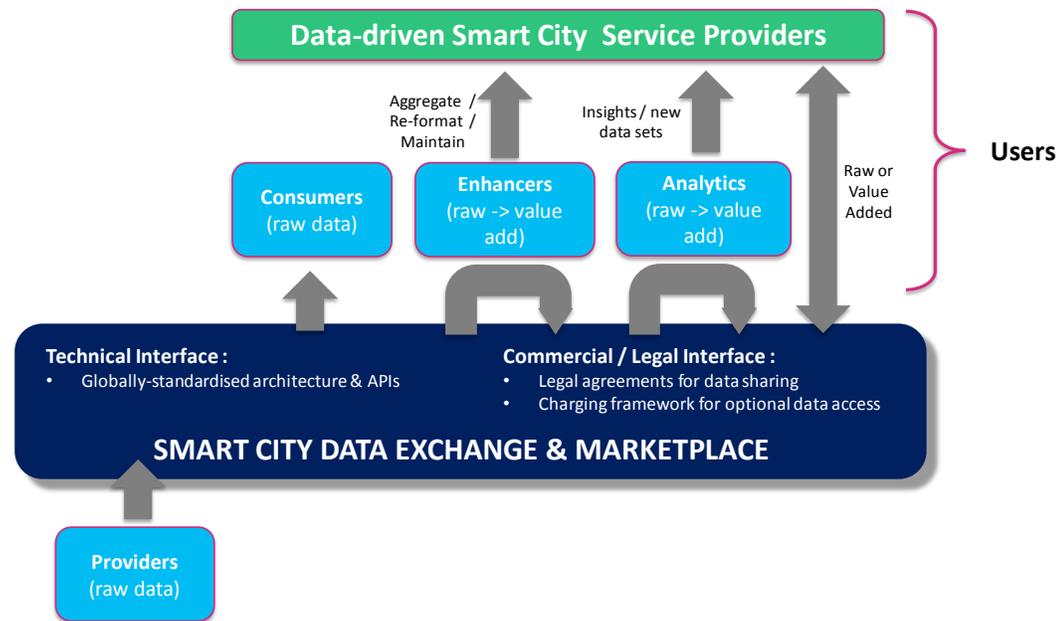


Figure 2 oneTRANSPORT data exchange and marketplace

how they perceived their data structures, their needs and their expectations. This approach ensured that the customer’s view took precedence in the solution design process.

With this information, technology vendors and experts defined a joint solution to fulfil all the given requirements. Subsequently, local authorities in the consortium “translated” technical concepts and applications into benefits and opportunities,

partners together to stimulate innovation and rapid technology transfer. A practical measure to achieve this in the oneTRANSPORT initiative was the creation of the Transport Data Initiative (TDI⁷). The TDI is a networking and knowledge sharing forum led by local authorities in the project.

The main tasks of the TDI are to help other authorities to understand the data economy and realize the potential benefits of opening data in a controlled way. Authorities that

⁷ <http://transportdatainitiative.com/>

take part in the TDI gain not just from their interactions with one another, but also from the input of multiple commercial and public entities willing to tackle transportation problems in a cooperative way with them. So far, the TDI has been instrumental in targeting the following issues:

- Common understanding of data economy and contracting schemes across authorities
- Existence of non-vendor-lock-in solutions to aggregate and publish data
- Current data-driven solutions for the transport sector and how to integrate them locally
- Benefits of re-using a common data platform to integrate data from multiple sectors
- Advantages of multi-region data integration

EARLY RESULTS POINT TO THE FOUNDATIONS FOR A LONG-TERM SOLUTION

One of the key findings from the oneTRANSPORT initiative is the need for close cooperation with the demand side (local authorities) of IoT platforms. This rich interaction between the demand side and solution vendors has led the in-field trials to target real issues, not only in the

deployment of technology, but also on the multiple legal and policy topics associated with data and real applications of the data marketplace.

In addition to setting up a data platform and data-related business models, an important goal was to create real use cases that could benefit from the trials. In the oneTRANSPORT initiative, the applications of the ecosystem centered on event management, categorized by their scale and frequency.

The first use case sought to provide better information for transport and traffic management for the Silverstone Formula 1 race and other large-scale events held at the same venue. The second use case involves traffic control for the Watford Football Stadium, which hosts more regular events. In the third use case, a park and ride scheme was monitored and interfaced with a mobility mobile apps for travelers visiting the Oxford city center. The common data platform, conceived with the aim of offering a high degree of flexibility, ensured that a single architecture could in fact accommodate these different use cases.

The governance of this multi-partner initiative consists of a lead partner, in this case InterDigital Europe, working in close cooperation with Arup, Buckinghamshire County Council and Imperial College to steer the direction of the activities.

Another more specific layer of control has seven key components: project management; Local Authority work; business models and exploitation; IoT

platform implementation; analytics development; sensor deployments; and operational evaluation. This structure offered a great level of control and assigned key accountable personnel to ensure the implementation of planned tasks and actions. This structure also allows for more flexibility and autonomy to implement solutions and achieve defined milestones. For such a complex undertaking, both in terms of scope and the number of new partner relationships, this governance model has been effective in keeping to the schedule and delivering tangible outputs.

The use of the oneM2M™ standard as a core technology was fundamental to create the concept of the open marketplace for data and data services. Before the initiative started, there was an understandable concern on the part of participating counties about the need for large sums of money to deploy proprietary solutions. There were other concerns about long-term contractual commitments, locking in to single technology or vendor solutions and solving the smart city challenge via solution silos. In contrast, the implementation of an open-standard-based solution gave authorities the reassurance of using a technology that multiple vendors can offer and, within some constraints, allow a like-for-like replacement of vendors to ensure services continuity.

In addition, the county authorities viewed oneM2M™'s federation capabilities as an opportunity to choose whether they wanted to integrate with other oneM2M™ systems belonging to other cities and vendors. Alternatively, they could keep more control by managing their own instance of the

standard directly, while not being isolated from others. Isolated solutions are the norm for current smart city deployments today. One of the main reasons for this is the need to pursue differentiation with the aim of becoming more attractive to investors. The problem with this approach is that it increases geographical and technical fragmentation which leads to higher start-up and operational costs because there are usually few opportunities to leverage economies of scale in a very closed and locked market.

Data privacy and security are important issues in the IoT and smart city sector. For the purposes of this trial, the security aspects of the implementation involved setting up multiple levels of registration and access control at a platform and dataset level. The approach taken to manage privacy was to aggregate data only after anonymization so personal identification is not possible at any level in the platform.

CONCLUSIONS

Advances in technology and innovation coupled with rising expectations for better and more responsive local authority services will alter the way that local authorities manage the services they deliver in cities and across regions. The smart city phenomenon does not apply solely to large and economically independent metropolitan areas. It is equally valid for small and medium sized cities and, progressively, to their urban and sub-urban conurbations. In such locations, however, economic factors

and access to 'smart' service-providers need to overcome lack-of-scale challenges.

The central issue for local authorities is to step beyond their core competencies to foster innovation in a range of services related to smart cities and regions. They should aim to: optimize investment; capitalize on best of breed expertise; and, lay the foundation for new ways of expanding the scope of services delivered to citizens and businesses that are the lifeblood of a local economy.

To embark on this journey, local authorities need to rethink conventional approaches to the smart city challenge. This means recognizing the limitations of investments in silo and single-technology solutions. Long-term success will result from putting in place the foundations of an operating environment to make best use of their connected assets and data streams and characterized by:

- An open-standards technology infrastructure that brings together data suppliers (including city data from different internal departments, national data from regional transport and public-safety authorities and, private sector data from citizens, infrastructure managers etc.) and data consumers (users of data such as application developers, 'smart' service providers etc.)
- A governance model for private-public sector partnerships which ensures that local authority requirements are clearly

articulated and addressed by multiple solution providers. The notion of working within a collaborative ecosystem ensures that local authorities benefit from best-of-breed expertise across the different technical, operational and commercial disciplines that are implicated in smart city services.

- A customer-centric forum to foster change management and ensure widespread and rapid adoption of smart city concepts through the sharing of promising ideas, discussion of implementation strategies and evangelization of success stories.

The purpose of the oneTRANSPORT initiative was to validate these principles. The project itself dealt with several areas of innovation which individual local authorities would not have had the means to fund from their day-to-day operational budgets. The initiative benefits greatly from the endorsement and funding provided by InnovateUK, the UK's innovation agency. This pattern of seed innovation in the public sector has parallels in other parts of the world, including the USA, through its SmartAmerica challenge.

The oneTRANSPORT initiative has achieved early success via several customer-led use

cases as well as market recognition⁸ for its innovative approach. Local authority users acknowledge the value of using the oneM2M™ standard in managing technology and vendor lock-in risks. Local authorities have also championed the Transport Data Initiative, a forum where local authority users share information about common requirements and solutions.

Finally, the concept of using a shared platform to aggregate city, regional and

national data has drawn interest from other smart city and intelligent transport initiatives around the world. The underlying platform in the oneTRANSPORT initiative now supports a second smart city project – the City of Birmingham’s Smart Routing⁹ citizen-enabled transport planning service - which operates in a different part of the UK and avoids the need for Birmingham to invest in building its own smart city platform.

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⁸ oneTRANSPORT wins award for best transportation and logistics solution at the IoT Solutions World Congress, 2016 - <http://www.iotsworldcongress.com/activities/iot-solutions-awards-gala/>

⁹ SmartRouting partners include the University of Aberdeen, Ayoupa, Birmingham City Council, Caution Your Blast and InterDigital Europe <https://www.smartrouting.co.uk/>